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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/820,525	04/07/2004	Qingguo Wu	NOVLP091/002889	8337

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EXAMINER	
MALDONADO, JULIO J	
ART UNIT	**PAPER NUMBER**
2823	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	03/28/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	10/820,525	WU ET AL.	
	Examiner	Art Unit	
	Julio J. Maldonado	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 December 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-33* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-33* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *20061212*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. The addition of claims 32 and 33 as set forth in the reply filed on 12/12/2006 is acknowledged.

2. Claims 1-33 are pending in the application.

Claim Objections

3. Claims 32 and 33 objected to because of the following informalities: in reference to claims 32 and 33 applicants recite, "The method of claim 1, wherein the deposited CDO layer...". However there is no description of a CDO layer in claim 1. The examiner suggests changing claims 32 and 33, from the above-mentioned language to -- The method of claim 1, wherein the deposited carbon doped oxide layer--. Appropriate correction is required.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1-16 and 18-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fukazawa et al. (U.S. 2006/0110931 A1, hereinafter Fukazawa) in view of the following comments.

Fukazawa (Fig.1) teaches forming a low-k dielectric layer for multilayered wirings, including the steps of providing a substrate (4) to a deposition chamber (1); providing an unsaturated carbon doped oxide precursor to the deposition chamber (1);

igniting and maintaining a plasma in the deposition chamber (1) using radio frequency power having high frequency and low frequency components, wherein at least about 1% to 50% of total radiofrequency is provided by the low frequency component, which has a frequency of 2MHz or less, the high frequency component has a frequency selected from the consisting of 13.56 MHz, 27 MHZ and 60 MHz, wherein the temperature of between 49°C to 550°C, and the pressure is between 1-10 Torr; depositing the low-k dielectric layer under said conditions, wherein said low-k dielectric layer has a dielectric constant of less than 3.5, and wherein the deposition chamber further comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor and can have a separation of, for example 24 mm (Fukazawa, [0034] – [0055] and [0068] – [0087]). Furthermore, Fukazawa teaches wherein the carbon doped oxide precursor can be 1, 3-divinyltetramethyldisiloxane (Fukazawa, [0045] – [0046]) and wherein said oxide layer has improved elastic modulus (Fukuzawa, [0029]).

Fukazawa fails to disclose wherein at least 2 percent of total radio frequency power is provided by the low frequency component, which has a frequency of between about 100kHZ and 600kHz, wherein the high frequency component has a frequency between 2 MHz and 60MHz, wherein the temperature is between 300 and 425°C, wherein the pressure is between 2 and 20 Torr, wherein the dielectric constant is not greater than about 3 and wherein the separation gap between the showerhead and the block is maintained at a distance of between about 5 mm and 100 mm. However, in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a

prima facie case of obviousness exists. MPEP 2144.05. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the frequency, separation gap, temperature and pressure to obtain the dielectric layer having the dielectric constant disclosed in Fukazawa to arrive at the claimed invention.

Still, Fukazawa fails to disclose wherein the low frequency component of the radio frequency power has a power of between about 0.02 and 20 Watts/cm^2 of the substrate surface area, and pulsing the high frequency component at a frequency of between about 500 Hz and 10 kHz during deposition having a duty cycle of between 20 and 80%. However, the selection of the recited power and frequency is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species to obtain desired deposition conditions. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to arrive at the recited specification through routine experimentation.

Fukazawa fails to disclose wherein the carbon doped dielectric layer has a residual tensile or compressive stress of magnitude less than about 50 MPa. However, the same material would be treated in the same manner and therefore the recited results would be obtained.

6. Claims 17 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fukazawa ('931) as applied to claims 1-16 and 18-31 above, and further in view of Rhee et al. (U.S. 7,087,271 A1, hereinafter Rhee).

Fukazawa substantially teaches all aspects of the invention including wherein the carbon doped oxide precursor has the general formula $Si_\alpha O_{\alpha-1} R_{2\alpha-\beta+2}(OR')_\beta$, wherein α is an integer of 1-3, β can be 0 and R is C_{1-6} hydrocarbon attached to Si and R' is C_{1-6} unattached to Si (Fukazawa, [0045] – [0046]). Fukazawa fails to disclose wherein the carbon doped oxide precursor is ethynyltrimethylsilane. However, Rhee teaches a related method to form low dielectric constant layers teaches providing a substrate in a CVD chamber; introducing carbon doped oxide precursor into the chamber; and depositing said low-k dielectric layer, wherein said carbon doped oxide precursor is selected from a group including ethynyltrimethylsilane (Rhee, column 3, lines 38 – 52). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Fukazawa and Rhee to enable depositing the low-k dielectric layer of Fukazawa using the precursor according to the teachings of Rhee because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of forming the disclosed low-k dielectric layer of Fukazawa and art recognized suitability for an intended purpose has been recognized to be motivation to combine (MPEP 2144.07), and furthermore, because this would result in dielectric layer with dielectric constant of less than 2.6 (Rhee, column 1, lines 56 – 60).

Still, the combination of Fukazawa and Rhee fail to expressly disclose wherein the deposited carbon doped dielectric layer has a carbon-carbon triple bond to silicon oxide bond ratio of about 0.05% to 20% based on FTIR pear area. However, the combination of Fukazawa and Rhee teach wherein one of the reactants used is

ethynyltrimethylsilane (Rhee, column 3, lines 38 – 52), which is a silicon containing compound having a carbon-carbon triple bond. Furthermore, the same materials are treated the same way and therefore, the same results would be obtained. Accordingly, the combination of Fukazawa and Rhee teach upon the claimed invention.

Response to Arguments

7. Applicant's arguments filed 12/12/2006 have been fully considered but they are not persuasive.

Applicants argue, "...Fukazawa, by contrast, relates to silicon carbides that are doped with oxygen. As described in Fukazawa, silicon carbides are used as barriers to prevent copper from diffusing into ILD layers and/or etch stop layers in damascene patterning of ILD layers. (See paragraphs 0016, 0019-0022, 0103 and 0104). The properties and uses of silicon carbide-based structures differ greatly from silicon-oxide based structures. The mechanical strength of silicon carbide layers such as those formed in Fukazawa does not tend to be an issue, because of the greater density and mechanical strength of silicon carbide-based structures. The structural distinction between the oxide layers and carbide layers is important as, for among other reasons, it allows etch selectivity between the oxide and carbide layer. Thus, the carbide layers may be used as etch stop layers as described in Fukazawa in a process to etch ILD CDO layers...". In response to this argument, paragraphs [0016] and [0019]-[0022] are directed to Fukazawa's Background of the invention, which was not relied upon on this rejection. Paragraph [0103] of Fukazawa teaches the dielectric constant and elastic modulus of an individual example. Paragraph [0104] of Fukazawa teaches evaluation

of etching parameters. Furthermore, Fukazawa teaches forming, for example, SiCOH films, wherein the silicon has an O- terminal (Fukazawa, [0026]). Therefore, the layer disclosed in Fukazawa is a silicon oxide film.

Conclusion

8. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

9. Applicants are encouraged, where appropriate, to check Patent Application Information Retrieval (PAIR) (http://portal.uspto.gov/external/portal/pair) which provides applicants direct secure access to their own patent application status information, as well as to general patent information publicly available.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Julio J. Maldonado whose telephone number is (571) 272-1864. The examiner can normally be reached on Monday through Friday.

11. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (571) 272-1907. The fax number for this group is 571-273-8300. Updates can be found at http://www.uspto.gov/web/info/2800.htm.

Julio J. Maldonado
Patent Examiner
Art Unit 2823

Julio J. Maldonado
March 21, 2007

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